Claims

[c1] 1. A method for controlling a hybrid electric vehicle powertrain having an internal combustion engine, a battery, an electric generator, an electric motor and a geared transmission, the geared transmission establishing a torque flow path from the engine to a torque output shaft, the method comprising the steps of:
determining desired input torque, vehicle speed and the state-of-charge of the battery;
determining whether the state-of-charge is less than a predetermined high value above which charging of the battery is not allowable;
determining whether the state-of-charge is greater than a predetermined target value;
operating the powertrain in a positive split mode when the state-of-charge is less than the high value and greater than the target value; and
operating the powertrain in a generator drive mode with the engine off when the state-of-charge is greater than the high value.

[c2] 2. The method set forth in claim 1, wherein the powertrain is operated in the positive split mode when the ve-

hicle speed is less than a predetermined value and the state-of-charge is less than the target value.

[c3] 3. The method set forth in claim 2, wherein the powertrain is operated in the generator drive mode when the state-of-charge is higher than the high value.

[c4] 4. The method set forth in claim 1, wherein the powertrain is operated in the positive split mode when the vehicle speed is greater than a maximum value and the state-of-charge is less than the target value and in a parallel power mode when the state-of-charge is greater than the target value;
the generator being braked to condition the powertrain for parallel operating mode.

[c5] 5. The method set forth in claim 1, wherein the powertrain is operated in the positive split mode when the vehicle speed is less than the maximum value and greater than the minimum value and the state-of-charge is less than the target value.

[c6] 6. The method set forth in claim 4, wherein the powertrain is operated in the parallel operating mode when the state-of-charge is greater than the target value.

[c7] 7. The method set forth in claim 6, wherein the powertrain is operated in the generator drive mode when the

state-of-charge is greater than the high value.

[c8] 8. A powertrain control system for a hybrid electric vehicle comprising an internal combustion engine, a battery, an electric generator, an electric motor and planetary gearing;
the planetary gearing including a sun gear connected to the generator, a ring gear drivably connected to a torque output shaft, and a planetary carrier connected to the engine;
a first brake for preventing rotation of the generator to condition the powertrain for a parallel operating power mode;
a second brake for preventing rotation of the planetary carrier to condition the powertrain for operation in a generator drive mode;
the generator being electrically coupled to the motor and the battery and the motor being drivably connected to the torque output shaft; and
a vehicle powertrain controller for detecting the state-of-charge of the battery and the vehicle speed;
the controller setting the powertrain for parallel power operating mode when the state-of-charge is greater than a target value and the vehicle speed is less than a maximum value;
the controller setting the powertrain for operation in

generator drive mode when the state-of-charge is greater than a predetermined high value and the vehicle speed is less than the maximum value.

[c9] 9. The powertrain control system set forth in claim 8, wherein the planetary gearing establishes multiple power flow paths from the engine to the torque output shaft, one power flow path being mechanical as the generator establishes a reaction torque on the sun gear and another power flow path being electromechanical as electrical power is transmitted from the generator to the motor, thereby conditioning the powertrain for operation in a positive split power mode.

[c10] 10. The method set forth in claim 5 wherein, during operation in the positive power-split mode, the desired engine torque = $K_1 * \tau_{driver}$ and $\omega_e = V_{veh}/K_1 + P_{batt}/\tau_e$, where:

K_1 = gear ratio from engine to driven wheels

τ_{driver} = driver's torque demand

τ_e = desired engine torque

ω_e = desired engine speed

P_{batt} = battery required charging power, and

V_{veh} = vehicle speed.

[c11] 11. The method set forth in claim 6 wherein, during operation in the parallel operating mode, the desired en-

gine torque = $K_1 * \tau_{driver}$ and $\omega_e = V_{veh}/K_1$, where:

K_1 = gear ratio from engine to driver wheels

τ_{driver} = driver's torque demand

τ_e = desired engine torque

ω_e = desired engine speed, and

V_{veh} = vehicle speed.

[c12] 12. The method set forth in claim 7 wherein, during operation in the generator drive mode, the desired generator torque =

$\tau_g = K_2 * \tau driver$

where:

τ_g = desired generator torque

K_2 = gear ratio from generator to vehicle wheels

τ_{driver} = driver's torque demand.